Claims 1-12 have been rejected under 35 U.S.C. § 112 as being indefinite for failing to particularly point out and distinctly claim the subject matter which the Applicants regard as the invention. Claims 1, 6, and 8 have been amended to overcome the objections noted by the Examiner.

Applicants' invention is an apparatus and method for manipulating virtual objects defined by a computer according to the gestures, positions, and movements of a part of the body (e.g., the hand) of an operator. Such manipulation includes positioning a cursor or other representation of the hand of the operator with respect to virtual objects defined by the computer. Operations on those virtual objects then may be carried out according to certain gesture-specifying movements of the operator's hand.

In one embodiment of the present invention, the gesture sensing means includes a glove assembly with attached sensors that are responsive to the degree of flex of the fingers of the operator's hand. In addition to the flex sensors, a hand orientation sensor provides data indicative of the orientation of the hand relative to the three rotational axes of roll, pitch, and yaw. The hand-position sensing means preferably includes one or more ultrasonic transmitters affixed to the glove assembly, a stationary receiver comprising three separate spaced apart ultrasonic receiving units, and a control circuit that measures the time delay of pulsed ultrasonic signals from the transmitter to the three receivers. The time delay provides a measure of the spatial position of the operator's hand. Interferace circuitry positions a hand-shaped cursor on the display screen of the computer according to the position, flexure, and orientation of the operator's hand. The device also includes a means for detecting contact between the cursor and a virtual object depicted on the display screen. Thus, the present invention provides a basis for use of a symbolic programming language in which the physical gestures of the operator's hand are used to implement conceptually familiar

functions or operations on virtual objects displayed on the display screen of the computer.

The invention is defined in the claims as follows:

Claim 1 recites glove means adapted to be worn on a hand of a user, the glove means including gesture sensing means coupled to the glove means for detecting flexure of fingers of the user's hand; position sensing means, coupled to the glove means, for detecting the position of the hand with respect to a display means; interface means for coupling the glove means to the computer; and control means for controlling a cursor indicated on the display means in response to the flexure of fingers and the position of the hand.

Claim 3 recites the gesture sensing means as further comprising flexure sensors affixed to the glove means to detect the extent of bending of the fingers of the user.

Claim 8 recites the display means as including means for displaying a representation of a hand which mirrors the position and flexure of fingers of the user's hand.

Claim 13 recites flex sensing means and cursor display means for displaying a cursor depicting the flexure of a part of the user's body.

Claim 24 recites an apparatus for manipulating a virtual object represented on a computer display comprising position sensing means, interface means for controlling a cursor indicated on the display in response to the position sensing means, and wherein the computer includes contact detecting means for detecting contact between the cursor and the virtual object.

Claim 33 recites an apparatus for controlling a computer display comprising orientation sensing means associated with a part of a user's body and cursor display means for displaying a cursor depicting the orientation of the part of the user's body.

Claims 30 and 43 recite the display means as displaying a virtual hand.

Claim 25 recites the virtual object being manipulated by the cursor and wherein the interface means includes object manipulating means for manipulating the virtual object in response to the contact detecting means and in response to the position of the part of the user's body with respect to the display.

Claims 18, 32, and 40 recite flex sensing means sensing the degree of flexure of the user's hand.

Claims 19, 32, and 41 recite the display means as displaying the degree of flexure of the user's hand.

Claims 22 and 24 recite position sensing means for sensing the position of the user's hand with respect to the display, and claims 23 and 45 recite the display means depicting the position of the user's hand.

Claims 31 and 46 recite the contact detecting means detecting when the virtual object is grasped by the virtual hand.

Claims 1-3 and 10-12 have been rejected under 35 U.S.C. § 103 as being unpatentable over Grimes in view of King, et al. This basis for rejection is respectfully traversed.

Grimes discloses a data entry device for a computer. The data entry device comprises a glove having a plurality of sensors disposed at selected locations thereon. The sensors are located so that when the hand is in a position which indicates a number or letter of the alphabet in sign language, then a signal is sent to the computer which indicates the letter or number depicted. A signal is transmitted to the computer only when the appropriate sensors for a given letter or number are activated.

Grimes also discloses a sensor for detecting when a part of the hand is flexed by a prescribed amount. However, the sensor acts as a switch and only detects when a prescribed amount of flexure is reached, and does not indicate the degree of flexure of the hand. Finally, it is not the function of Grimes to control a cursor in response to gestures of the hand. Instead, the device

merely transmits letter and number data corresponding to the hand signal to the computer.

King, et al. discloses a light pencil which may be used for positioning a cursor on a computer screen. In particular, the light pencil includes four LED's, A, B, C, and D, which radiate infrared light for a sensor 16 disposed on the computer display. The sensor 16 receives the signals from the LED's A, B, C, and D, and determines where to place the cursor based upon the characteristics of signals received.

As noted above, the present invention provides a basis for use of a symbolic programming language in which the physical gestures of a part of the user's body are converted into a virtual operator for implementing easily recognizable functions or operations on virtual objects displayed on the display screen of the computer. In order for a virtual operator to operate on virtual objects in a manner resembling the manipulation of real objects, the virtual operator must be capable of movement resembling the real part of the body it represents. More specifically, the cursor display must be capable of depicting position, flexure, and/or orientation of the relevant part of the user's body, so that virtual objects may be grasped, poked, pushed, turned, or otherwise manipulated about the display. For example, the user's hand may be converted to a virtual hand which, in turn, may be used for grasping a virtual steering wheel for driving a simulation of an automobile. To do this, the display must be capable of controlling a cursor in response to the flexure of fingers and the position and/or orientation of the hand.

In Grimes, the glove acts like a conventional keyboard and merely transmits letters to the computer. The position, orientation, and/or flexure of the hand is not depicted by the Grimes cursor. King, et al. discloses using a pencil worn on the head of the user to position a cursor on the computer screen, but again, the cursor does not depict flexure, orientation and/or

position of an associated part of the body, as claimed by the Applicants. Furthermore, since neither Grimes nor King, et al. is concerned with manipulation of virtual objects with the cursor, there is no motivation to make such a depiction. Thus, since neither reference discloses nor suggests the important functions and results recited in the claims, and since neither reference provides any motivation to one of ordinary skill in the art to modify or combine their teachings in order to control a cursor in response to flexure of fingers and the position of the hand, or otherwise depict the position, orientation, and/or flexure of a part of the body of the user, the subject matter of Applicants' claims 1-3 and 10-12 are not rendered obvious thereby.

The foregoing arguments apply to the newly added claims as well. Furthermore, neither reference discloses nor suggests a means for sensing contact between a cursor and a virtual object, as recited in claims 24 and 46.

Claims 4-7 and 9 have been rejected under 35 U.S.C. § 103 as being unpatentable over Grimes in view of King, et al., as applied to claims 1 and 2 above and further in view of Davison and Herrington, et al. Since claims 4-7 and 9 incorporate the limitations of claim 1, and since it is believed that claim 1 is patentable over the cited art, it is respectfully submitted that claims 4-7 and 9 are patentable for the same reason.

Accordingly, it is believed that the rejections under 35 U.S.C. §§ 103 and 112 have been overcome by the amendment and remarks, and it is submitted that the claims are in condition for allowance. Reconsideration of this application as amended is respectfully requested. Allowance of all claims is earnestly solicited.

TWO ~~ONE~~ MONTH EXTENSION GRANTED
By Direction
Primary Examiner
6/10/88
Clerk, Group 260 Date

Respectfully submitted,

TOWNSEND and TOWNSEND

By: James A. Deland
James A. Deland
Reg. No. 31,242

JAD:jmj
#10274-1
415/543-9600